Alexander TOKARČÍK[1]
Henrieta PAVOLOVÁ[2]
Tomáš BAKALÁR[3]
Lucia BEDNÁROVÁ[4]

IMPACT OF INNOVATIONS ON THE SAVING OF THE PRODUCTION COMPANY'S WORKING TIME FUND

The article deals with innovation management in the conditions of a manufacturing company whose aim is to reduce the working time fund that directly determines productivity or efficiency of the company in competitive market conditions. Based on explicit quantification of time frames based on an analytical – chronometric method applicable to production operations in the process. The results of observation, time measurement, research and evaluation of time consumption during the implementation of a repeated production operation, or its complex part within defined production site are presented. Based on explicitly performed quantitative analysis, introducing of innovative technology, innovative solutions in the field of production technology management that support sustainable development with an emphasis on the development of environmental quality are presented including an explicit quantification of working time fund savings through the implementation of innovative machinery and equipment in critical production operations of the analysed production process.

Keywords: innovation, saving time, critical points of the production process.

1. INTRODUCTION

Innovation is a way of life of the company that intervenes in all partial components of the reproduction process (marketing, product and technology development, planning, production, sales, staff training, management, etc.) (Kováč et al., 2011). If the company identifies with the innovation strategy, then it is characterized by a high share of innovative products in the sales structure, the use of advanced technology with innovative management

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[1] Alexander Tokarčík, MSc., PhD, Energy Cluster of Prešov Region, Slovak Republic; e-mail: klasterekpk@gmail.com
[2] Henrieta Pavolová, Assoc. prof., MSc., PhD, Technical University of Košice, Faculty of Mining, Ecology, Process Control and Geotechnologies, Letná 9, 042 00 Košice, Slovak Republic; e-mail: henrieta.pavolova@tuke.sk (corresponding author). ORCID: 0000-0002-6507-0486.
[3] Tomáš Bakalár, Assoc. prof., MSc., PhD, Technical University of Košice, Faculty of Mining, Ecology, Process Control and Geotechnologies, Letná 9, 042 00 Košice, Slovak Republic; e-mail: tomas.bakalar@tuke.sk. ORCID: 0000-0002-6985-9935.
[4] Lucia Bednárová, Assoc. prof. Ing. PhD, Technical University of Košice, Faculty of Mining, Ecology, Process Control and Geotechnologies, Letná 9, 042 00 Košice, Slovak Republic; e-mail: lucia.bednarova@tuke.sk. ORCID: 0000-0002-8582-0643.

(Dicová, 2008, Carter et al., 2001). For customers in the market (Estélyiová, 2007). The aim of innovation in the company is to increase sales to customers and to ensure quality as well as productivity towards the inside of the company, or efficiency. Subsequently, these facts are reflected in the philosophy of the company and its brand (Damanpour, Gopalakrishnan, 2001). In terms of costs, technology innovation is more demanding than product innovation, but in terms of market dominance, it is necessary to combine these innovations. Innovation in companies has its specifics presented in the form of risk, which is associated with the vision of success, the danger of failure and loss (Henriques, Sadorsky, 2007). Customer-oriented innovations need a source of ideas for new products and services, which are based primarily on their own analysis of the relevant market segment and customer behaviour in it (Ivanová, Tomanová, 2014). Therefore, companies in the region are concentrated in clusters, where they use their specific environment and available professional capacities.

By analysing the company's position in the market, it is possible to understand its overall situation in comparison with similar business entities (Vivero, 2002). The results then help to identify reserves related to innovations in the company and point to the positive development of the company's activities in reducing energy intensity. An important step in the process of increasing innovation is to focus on extensive data collection on production processes, as well as to analyse the individual production operations that take place on them (Budziakowski, 2016).

2. AIM, SCOPE AND SUBJECT MATTER

The aim of the case study was an exact analysis of the time consumption of partial production operations of the production process in the real conditions of the production company. Based on a detailed analysis of the time consumption of partial production operations, critical points of the production process of the final product were identified. In terms of identifying critical areas of the working time fund, production innovations of mechanical and technical equipment were proposed, the implementation of which would save the working time of the production process with an emphasis on maintaining the competitiveness of the production company, increasing productivity and environmental responsibility in accordance with the principles of sustainable development.

3. RESEARCH METHODOLOGY

For a detailed analysis of partial production operations in the production process and the normative of time consumption, the measurement was performed directly at the workplace using the method of analysis – chronometry. The time frame of the operation (chronometry) was used to determine the production time for individual production operations. The time frame of the operation is a part of working frames and captures the results of observation, measurement, examination and evaluation of time consumption when performing a certain repetitive production operation, or part of it at the workplace of an individual. Time consumption was measured using a stopwatch. During the analysis of a specific production process, its partial production operations were identified, which is illustrated in detail in Figure 1.
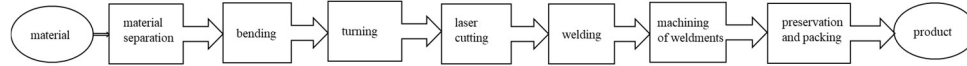
Figure 1. Production process in the analysed company

Source: Authors' own elaboration.

For the needs of compiling partial operations, the consumption of working hours of individual production operations was quantified by the analysis – chronometric method, based on which innovations of the production process were designed in the form of mechanical – technical equipment operating on the basis of systemic understanding of environmentally responsible company.

4. RESULTS AND DISCUSSION

For the analysed production process consisting of partial production operations (Figure 1), time frames with exactly identified time consumptions of individual work operations were constructed as follows:

- Time frame of the material separation, which uses a high-performance automatic band saw BOMAR transverse 610.440 GA with a cutting range up to 610 x 440 mm (Table 1).

Table 1. Material cutting by automatic saw

Operation	Measurements [min]									
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
1	6	7.23	7.49	7.33	10.38	9.14	9.39	8.44	8.91	8.63
2	10.25	9.36	8.56	9.68	8.05	8.85	9.01	9.89	8.78	8.97
3	15	14.69	15.67	15.77	15.76	18.45	17.54	18.23	15.89	15.92
4	6.12	6.05	5.61	5.56	6.15	6.54	5.24	6.67	5.57	5.56
5	1.74	1.83	1.83	1.74	1.95	2.01	1.35	1.29	2.13	2.58
Σ	**39.11**	**39.16**	**39.2**	**40.08**	**42.3**	**45**	**42.5**	**44.5**	**41.3**	**41.7**

Total measurement time	414.78	=	Average measurement time 41.478 minute per piece			
Number of measurements	10					
Maximum measurement time:	44.99 min.		Minimum measurement time: 39.11 min.			
U_A standard uncertainty:	0.26	Precision:	8.47%	-5.71%		
Time consumption = 0.69 hour per piece						

Notes: 1 – Loading drawing documentation, 2 – Material selection, 3 – Sawing, 4 – Control of separated material, 5 – Material storage.

Source: Authors own elaboration.

- Ermak Speed bend material bending time frame, which provides bending with the required accuracy and speed, while repeatable accuracy is possible thanks to the synchronization of the hydraulic cylinders with the servo-valves, and automatic axis indexing at machine start-up calibration (Table 2).

Table 2. Material bending with Ermak Speed bend

Operation	Measurements [min]									
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
1	3.34	3.47	3.56	3.39	3.45	3.3	3.37	3.44	3.43	3.39
2	10.61	10.34	10.65	10.3	10.41	9.85	10.18	10.22	10.18	10.24
3	10.66	10.35	10.53	10.2	10.39	9.76	10.12	10.28	10.19	10.22
4	1.01	1.86	1.87	1.76	1.85	1.72	1.83	1.83	1.75	1.84
5	2.23	1.72	1.64	2.02	1.98	1.97	2.31	1.96	2.22	1.97
6	1.45	1.1	1.13	1.17	1.15	1.08	1.18	1.05	1.22	1.12
7	0.62	0.71	0.58	0.62	0.68	0.76	0.66	0.77	0.69	0.65
8	15.04	15.12	15.15	14.84	14.96	14.43	14.63	14.92	14.62	14.4
9	0.48	0.64	0.48	0.82	0.43	1.18	0.6	0.63	0.59	0.6
10	0.21	0.21	0.24	0.36	0.26	0.26	0.33	0.34	0.27	0.22
4	1.88	1.86	1.87	1.76	1.85	1.72	1.83	1.86	1.75	1.84
6	1.14	1.1	1.13	1.17	1.15	1.04	1.18	1.05	1.12	1.09
7	0.65	0.69	0.48	0.61	0.64	0.74	0.72	0.68	0.71	0.69
8	14.84	14.82	15.05	14.64	15.12	14.48	14.83	14.92	15.12	14.51
9	0.52	0.48	0.62	0.82	0.75	1.09	0.94	0.83	1.08	0.97
10	0.19	0.24	0.23	0.37	0.39	0.34	0.38	0.31	0.34	0.29
11	14.88	16.39	18.02	14.62	14.13	15.16	18.19	17.83	19.57	14.36
12	0.12	0.11	0.12	0.13	0.11	0.15	0.13	0.12	0.13	0.14
Σ	79.87	81.21	83.35	79.6	79.7	79.03	83.41	83.04	84.98	78.54

Total measurement time	812.73	=	Average measurement time 81,273 minute per piece		
Number of measurements	10				
Maximum measurement time:	84.98 min.		Minimum measurement time: 78,54 min.		
U_A standard uncertainty:	0.08	Precision:	4.56%	-3.36%	
Time consumption = 1.35 hour per piece					

Notes: 1 – Loading drawing documentation, 2 – Creating a bending program, 3 – Tool selection against material, 4 – Material inspection – dimensionality, 5 – Attaching the tool to the press brake, 6 – Starting the program, 7 – Inserting material, 8 – Ram lower => zoom – bend, 9 – Gauge bending check, 10 – Gauge bending check, 11 – Bending repair – product finalization, 12 – Product storage.

Source: Authors own elaboration.

- Turning time frame using a TOS SV 18 RA type lathe, which is a manual, universal centre lathe and represents a highly precise and powerful machine, well usable especially in small series and piece production (Table 3).
- Laser cutting time frame, which uses two types of cutting gases, oxygen and nitrogen. During oxygen laser cutting, the material is burned and an oxidized layer unsuitable for surface treatment is formed on its edges. During nitrogen cutting, the material melts, which is then blown out of the dividing track (Table 4).
- Welding time frame, which is the process of making a permanent joint by forming interatomic bonds between the welded parts during heating or plastic deformation or by the action of both (Table 5).

Table 3. Turning

Operation	Measurements [min]									
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**
1	2.85	2.34	2.49	2.68	2.94	2.62	2.7	2.44	2.58	3.02
2	8.52	10.01	8.09	9.42	8.98	9.24	8.85	8.78	8.75	8.97
3	2.27	2.42	2.43	2.43	2.48	2.46	2.42	2.38	2.46	2.58
4	4.64	4.59	4.58	4.58	4.48	4.38	4.61	4.82	4.59	4.48
5	17.44	16.95	15.71	14.93	15.56	16.84	16.82	17.19	17.64	16.59
6	1.44	1.94	3.09	2.57	1.84	2.05	2.93	3.12	2.72	2.35
7	3.35	2.98	3.51	3.43	3.45	3.27	3.15	3.42	3.15	3.28
8	6.57	6.7	6.84	6.69	6.74	6.54	6.51	6.82	6.72	6.75
9	1.94	2.33	1.76	2.47	2.34	2.18	1.98	1.78	1.99	1.97
10	3.35	3.45	3.35	3.42	3.23	3.54	3.48	3.18	3.24	3.35
9	1.94	2.33	1.76	2.47	2.3	2.1	1.87	1.71	1.9	1.95
11	3.35	3.17	3.35	3.34	3.23	3.13	3.13	3.17	3.13	3.08
12	0.49	0.36	0.42	0.3	0.37	0.34	0.37	0.34	0.32	0.42
13	0.44	0.47	0.47	0.51	0.46	0.46	0.47	0.45	0.47	0.46
14	1.37	1.48	1.39	1.41	1.45	1.39	1.34	1.41	1.39	1.45
15	0.43	0.48	0.45	0.49	0.43	0.45	0.48	0.42	0.44	0.42
Σ	60.39	62	59.69	61.08	60.29	60.99	61.11	61.42	61.42	61.13

Total measurement time	609.57									
Number of measurements	10	=	Average measurement time 60.957 minute per piece							
Maximum measurement time:	62.00 min.		Minimum measurement time: 59.69 min.							
U_A standard uncertainty:	0.07	Precision:	1.71%	-2.09%						
Time consumption = 1.02 hour per piece										

Notes: 1 – Loading drawing documentation, 2 – Semi-finished product inspection, 3 – Material clamping, 4 – Cutting tool selection, 5 – Tool clamping 6 – Zoom tool, 7 – Turning, 8 – Product rotation, 9 – Zoom tool, 10 – Turning, 11 – Drilling, 12 – Termination of activities on the facility, 13 – Product removal, 14 – Product measurement and control, 15 – Product storage.

Source: Authors own elaboration.

Table 4. Laser cutting

Operation	Measurements [min]									
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**
1	12.5	12.87	14.22	14.94	16.61	14.63	15.03	13.51	14.26	13.81
2	46.81	55.06	46.01	52.51	50.74	51.59	49.25	48.61	48.62	49.93
3	13.41	12.31	13.87	12.32	14.01	13.74	12.48	13.18	13.6	14.36
4	26.65	25.68	26.58	25.49	25.84	24.86	25.98	26.67	25.61	24.89
5	10.91	9.83	9.86	9.28	10.49	10.8	11.92	10.3	10.74	10.97
6	16.88	15.87	17.64	14.33	13.22	15.45	16.31	17.28	15.04	14.08
7	61.54	61.34	60.04	60.48	60.49	61.26	60.53	62.04	61.59	60.89
5	18.14	17.42	19.12	18.62	18.25	17.46	17.41	17.52	17.29	17.13
6	1.18	1.82	1.05	1.77	1.22	1.17	1.02	1.86	1.25	1.59
7	76.48	77.58	76.84	76.98	78.02	78.06	77.68	78.04	77.95	78.88

Table 4 (cont.). Laser cutting

Operation	Measurements [min]									
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**
5	13.34	12.81	12.02	13.74	12.99	11.71	10.41	11.44	11.49	12.84
6	1.14	1.99	2.39	1.65	2.1	1.91	2.05	1.88	1.78	2.36
7	26.76	28.48	29.13	25.16	24.98	28.77	29.44	27.33	29.02	27.58
8	7.57	6.58	6.92	7.24	7.98	6.84	7.05	6.92	6.97	7.34
Σ	**333.31**	**339.63**	**335.7**	**334.5**	**336.94**	**338.3**	**336.6**	**336.6**	**335.2**	**336.7**

Total measurement time	3363.32	=	Average measurement time 336.332 minute per piece
Number of measurements	10		
Maximum measurement time:	339.32 min.		Minimum measurement time: 333.31 min.
U$_A$ standard uncertainty:	0.26	Precision: 0.98%	-0.90%
Time consumption = 5.61 hour per piece			

Notes: 1 – Creation of technological process, 2 – Programming, 3 – Material typing, 4 – Creation of technological process, 5 – Material selection, 6 – Material focus, 7 – Laser cutting, 8 – Product storage and surplus.

Source: Authors own elaboration.

Table 5. Welding

Operation	Measurements [min]									
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**
1	5.48	5.87	6.22	4.94	5.61	4.92	5.23	6.51	4.26	5.81
2	9.14	9.06	9.01	9.54	9.74	9.59	10.25	8.61	8.62	9.93
3	18.28	19.32	20.87	18.32	16.01	18.74	18.47	19.18	16.6	18.36
4	137.12	140.68	135.56	125.49	142.81	134.86	135.98	136.57	145.71	144.79
5	13.71	13.84	13.86	14.28	16.49	13.78	12.94	12.29	13.71	12.83
6	164.55	158.87	172.64	169.35	173.28	165.42	169.93	170.88	165.04	164.98
7	9.14	9.35	9.12	10.48	10.46	9.26	9.53	10.12	9.64	9.72
8	20.57	20.46	20.34	20.64	19.98	20.49	18.97	20.13	20.06	19.67
Σ	378	377.45	387.62	373.04	394.38	377.06	381.3	384.29	383.64	386.09

Total measurement time	3822.86	=	Average measurement time 382.286 minute per piece
Number of measurements	10		
Maximum measurement time:	394.38 min.		Minimum measurement time: 373.04 min.
U$_A$ standard uncertainty:	0.30	Precision: 3.16%	-2.24%
Time consumption. = 6.37 hour per piece			

Notes: 1 – Loading drawing documentation, 2 – Inspection and preparation of components, 3 – Clamping parts, 4 – Scoring, 5 – Control, 6 – Welding, 7 – Dimension check, 8 – Inter-operational inspection and Material storage.

Source: Authors own elaboration.

- A precision machining time frame that is a collection of technological processes that change the appearance and functionality of a metal part to modify its properties, extend functionality, or modify design. This production operation was carried out using WHN 13 CNC, which is a universal CNC machine for precision horizontal milling, coordinate drilling and boring, thread cutting for box, plate and complex work pieces weighing up to 12,000 kg (Table 6).
- Time frame of preservation and packaging, which achieves the protection of all metal parts during transport and storage at the customer (Table 7).

Table 6. Precise machining

Operation	Measurements [min]									
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
1	30.12	32.81	30.98	29.76	30.45	31.83	30.64	30.99	31.97	30.76
2	50.23	52.48	51.54	51.83	49.82	50.94	51.22	48.98	50.34	50.98
3	10.73	10.02	9.24	11.64	16.54	14.4	10.81	11.88	12.67	10.84
4	60.37	63.72	59.28	58.76	61.82	63.83	60.74	64.72	62.21	59.88
5	10.71	10.29	12.41	11.92	12.63	9.81	9.43	9.68	10.91	11.49
6	6.16	6.62	7.75	8.83	8.86	7.64	7.94	8.34	8.46	9.12
7	16.76	16.28	17.95	17.63	18.14	18.46	16.12	17.65	17.48	18.46
8	8.13	9.63	8.06	8.9	9.34	8.92	9.63	9.77	8.54	9.34
9	5.98	5.74	7.87	9.53	8.56	8.82	8.36	7.84	8.42	9.41
10	4.9	5.32	4.83	6.41	6.41	7.63	8.12	5.18	6.03	7.12
6	5.16	5.62	7.35	5.36	6.23	5.26	7.9	6.34	5.66	6.81
7	55.76	56.28	59.68	57.41	52.28	54.76	56.81	57.65	57.48	54.76
8	15.13	16.64	16.94	15.89	15.01	15.24	16.46	15.88	16.16	15.41
9	10.94	10.74	9.87	10.93	9.98	12.23	9.92	12.34	10.73	10.16
10	6.95	7.32	8.81	5.98	6.15	7.58	5.67	7.34	6.83	6.12
6	5.23	5.62	7.35	5.63	8.45	7.84	5.01	3.95	6.63	6.14
7	30.63	31.28	30.86	42.02	39.2	43.94	30.42	33.81	32.88	37.67
8	12.73	14.64	13.94	12.21	14.12	11.34	12.83	11.74	16.97	13.21
9	7.89	8.74	7.83	8.23	7.78	8.54	7.81	7.48	8.64	8.21
10	11.97	12.32	14.83	13.41	18.95	12.63	13.64	11.95	12.36	11.46
6	5.67	6.62	7.35	11.36	9.24	6.26	8.74	6.81	7.75	7.48
7	31.03	66.28	29.88	32.31	34.28	36.34	31.92	32.65	33.78	32.54
8	12.34	12.63	11.94	11.85	12.4	11.34	11.83	12.36	11.84	13.42
9	7.94	8.74	7.73	9.53	8.76	9.12	7.63	8.14	8.18	8.035
10	10.95	9.36	11.83	8.4	9.92	12.41	11.94	12.14	11.98	9.87
6	5.64	5.62	7.35	6.36	5.34	5.56	5.83	7.36	7.78	6.81
7	31.02	36.21	39.86	32.41	30.12	29.92	32.53	31.14	29.58	29.74
8	11.73	13.64	16.45	14.72	33.72	12.67	11.93	12.34	11.94	12.63
9	7.98	8.48	7.87	8.16	7.99	7.57	7.59	8.71	8.63	7.94
10	12.59	11.36	12.83	13.16	14.62	13.35	11.34	18.58	18.35	17.61
11	9.77	9.78	9.35	8.76	11.28	10.86	17.34	11.94	11.85	12.47
12	2.51	2.56	2.62	2.17	3.63	2.94	3.85	3.56	3.73	3.64

Table 6 (cont.). Precise machining

Operation	Measurements [min]									
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
13	7.72	8.12	7.82	7.98	8.74	7.87	9.58	8.09	7.86	8.24
14	12.56	13.31	12.45	13.95	14.32	12.83	13.4	11.26	12.02	12.97
15	3.46	2.61	2.54	2.7	3.97	3.35	3.63	2.43	2.53	2.43
Σ	539.39	597.43	575.24	576.1	608.56	584.03	568.56	571.02	571.02	573.175
Total measurement time	5772.675	=	Average measurement time 577.2675 minute per piece							
Number of measurements	10									
Maximum measurement time:	84.98 min.		Minimum measurement time: 539.39 min.							
U_A standard uncertainty:	0.57	Precision:	5.42%	-6.56%						
Time consumption = 9.62 hour per piece										

Notes: 1 – Loading drawing documentation, 2 – Creating a drilling program, 3 – Tool selection against material, 4 – Weldment clamping, 5 – Measuring probe measurement, 6 – Inserting a machining tool, 7 – Execution of the program, 8 – Product release, 9 – Product position change, 10 – Measuring probe measurement, 11 – Control measurement, 12 – Product cleaning, 13 – Product release, 14 – Product transfer, 15 – Product storage.

Source: Authors own elaboration.

Table 7. Preservation and packaging

Operation	Measurements [min]									
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
1	15.02	14.86	14.97	15.45	14.76	15.48	14.77	15.12	15.03	15.24
2	6.15	6.24	6.16	6.58	7.12	6.82	6.79	6.44	7.15	7.42
5	10.12	10.45	9.94	10.23	10.41	10.15	9.93	9.75	10.2	9.84
Σ	31.29	31.55	31.07	32.26	32.29	32.45	31.49	31.31	32.38	32.5
Total measurement time	318.59	=	Average measurement time 31.859 minute per piece							
Number of measurements	10									
Maximum measurement time:	32.50 min.		Minimum measurement time: 31.07 min.							
U_A standard uncertainty:	0.02	Precision:	2.01%	-2.48%						
Time consumption = 0.53 hour per piece										

Notes: 1 – Product cleaning, 2 – Preservative application, 3 – Packing.

Source: Authors own elaboration.

Based on a detailed analysis of time frames of partial operations in terms of the analysis – chronometry method. identified critical points were identified and are included in Table 8:

- bending: a critical point in bending repair, i.e. product finalization,
- turning: critical points in partial production operations including turning the product and approaching the tool.
- precise machining: critical points in partial production operations including uncoupling the product. changing the position of the product and measuring with a measuring probe.

Table 8. Identification of critical points in the production process

Manufacturing operation	Bending										
Recalculation of critical points	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	In sum
11[%]	18.63	20.18	21.62	18.37	17.73	19.18	21.81	21.47	23.03	18.28	**20.07 %**
Manufacturing operation	Turning										
Recalculation of critical points	M2	M3	M4	M5	M6	M7	M8	M9	M10		In sum
8[%]	10.81	11.46	10.9	11.18	10.72	10.65	11.10	10.93	11.04		**14.37 %**
9[%]	3.7	2.95	4.04	3.88	3.57	3.24	2.90	3.24	3.22		
Manufacturing operation	Precise machining										
Recalculation of critical points	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	In sum
8[%]	11.13	11.24	11.7	11.03	13.9	10.19	11.02	10.87	11.3	11.17	**27.84 %**
9[%]	7.55	7.1	7.16	8.05	7.08	7.92	7.27	7.79	7.7	7.63	
10[%]	8.78	7.65	9.24	8.22	9.13	9.18	8.92	9.67	9.59	9.1	

Source: Authors own elaboration.

In view of the above, based on the identified critical points of the working time fund according to a clear quantification of partial production operations in terms of analytical – chronometric method of measuring time frames it can be concluded that individual machinery should be implemented in the above production operations:

- LVD EasyForm9 220/30 press brake in the identified critical bending operation,
- CNC lathe Spinner TC600-65 MC in the identified critical turning operation,
- Milling head WHN 13 CNC with milling head HUI 50 in the identified critical operation precision machining.

Subsequently, the quantification of time savings that can be achieved in clearly identified production operations and their critical points where the following savings of the working time fund can be achieved was performed:

- by implementing and using the LVD EasyForm9 220/30 press brake. it is possible to achieve savings of 31.14% of working time (Table 9),

- implementation and use of CNC lathe Spinner TC600-65 MC can achieve savings of 24.27% (Table 10). while the quantification in question does not consider the compatibility of technical parameters in the production process, i.e. increasing time savings in product implementation,
- by implementing and using the WHN 13 CNC milling head with the HUI 50 MC milling head, it is possible to achieve a saving of 28.76% (Table 11), while the quantification in question does not take into account the compatibility of technical parameters in the production process. i.e. increase time savings in product implementation.

Table 9. Quantification of bending working time savings

Save time when deploying LVD EasyForm9 220/30							
Average time per operation							
Operation	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
before	3.41	10.3	10.27	1.73	2	1.17	0.67	14.81
after	3.41	10.3	3.49	1.73	2	1.17	0.4	14.09
Operation	**9**	**10**	**4**	**6**	**7**	**8**	**9**	**10**
before	0.65	0.27	1.82	1.12	0.66	14.83	0.81	0.31
after	0.22	0.27	1.82	1.12	0.4	14.83	0.28	0.31
Operation	**11**	**12**					**SUM**	**Time saving 31.14%**
before	16.32	0.13					81.273	
after	0	0.13					55.968	

Source: Authors own elaboration.

Table 10. Quantification of bending working time savings

Save time when using the Spinner TC 600-65 MC							
Average time per operation							
Operation	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
before	2.67	8.96	2.43	4.57	16.57	2.41	3.3	6.69
after	2.67	8.96	2.43	4.36	15.79	1.39	2.31	0
Operation	**9**	**10**	**11**	**12**	**13**	**14**	**SUM**	**Time saving 24.27 %**
before	2.07	3.36	2.03	3.21	0.37	0.47	60.957	
after	0	2.35	0	3.21	0.37	0.47	46.164	

Source: Authors own elaboration.

Table 11. Quantification of precision machining time savings

Time saving when using WHN 13 CNC with HUI 50 milling head							
Average time per operation							
Operation	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
before	31.03	50.836	11.88	61.53	10.93	7.972	17.493	9.026
after	31.03	50.836	11.88	61.53	10.93	7.972	16.968	0
Operation	**9**	**10**	**6**	**7**	**8**	**9**	**10**	**6**
before	8.053	6.146	6.169	56.29	15.88	6.875	6.185	0.31
after	0	0	6.169	54.6	0	0	6.185	0.31
Operation	**7**	**8**	**9**	**10**	**6**	**7**	**8**	**9**
before	35.27	13.373	8.115	13.35	7.728	36.1	12.195	8.3805
after	34.21	0	0	0	7.728	35.02	0	0
Operation	**10**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
before	10.88	6.365	32.25	15.18	8.092	14.38	11.34	3.121
after	0	6.365	31.29	0	0	0	11.34	3.121
Operation	**13**	**14**	**15**				**SUM**	**Time saving 28.76 %**
before	8.202	12.907	2.965				577.27	
after	8.202	12.907	2.965				411.24	

Source: Authors own elaboration.

From the above comparative quantifications of the proposed innovative measures. which were identified based on explicit quantifications of critical points of partial operations it can be stated that the use of the proposed innovative measures will determine the working time savings of 15.22% (Table 12).

Table 12. Quantification of the benefits of introducing innovative elements into the production process

	The production process today	**Proposed production process**
Beginning		
Laser cutting	336.332	336.332
Sawing	41.478	41.478
Bending	= 2 x 81.273 = 162.546	= 2 x 55.968 = 111.936
Turning	= 3 x 60.957 = 182.871	= 3 x 46.164 = 138.492
Welding	382.286	382.286
Precise machining	577.268	411.242
Conservation	31.859	31.859
End		
SUM in minutes	1 714.64	1 453.63
	Saved time:	**15.22%**

Source: Authors own elaboration.

5. SUMMARY AND CONCLUSION

Innovation of products, machine – technical equipment, or the whole technological process clearly contribute not only to maintaining the competitiveness of the company but also to its environmental responsibility in the exploitation of terrestrial and other natural resources in favour of the use of renewable resources and to reduce the emission of pollutants including CO and CO_2 which also contribute to the implementation of the so-called low carbon technologies. Purchase of new machinery and equipment that can work in various production regimes not only increases the quality but also the energy demand. The merger must consider activities at individual workplaces into one continuous operation on machinery which will reduce the need for manipulation or operational adjustment of the machine and at the same time reaches min. 10% savings energy in the flow of production. An important aspect is working in multiple axes or at different angles.

Such mechanical - technical equipment can during smooth operation control and self – exchange reduce the time required for the final product by more than 15% over time production process. If processes increasing production efficiency while increasing labour fund savings time of human activity of the company will be based on innovation in production then the company will gain significant market position, reduce the negative impact on environmental quality and increase energy efficiency.

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